A DISJUNCT PONDEROSA PINE STAND IN SOUTHEASTERN OREGON[1]

Arthur McKee[2] and Donald Knutson[3]

Abstract.—An isolated stand of ponderosa pine (*Pinus ponderosa*) is surviving on an extremely harsh site in southeastern Oregon. Seed production is low because of insects, primarily pine coneworm (*Dioryctria auranticella*), feeding in developing cones. Seedling establishment is infrequent and difficult because of drought and coarse, rocky soils. A rock-mulch soil surface probably reduces interspecific competition. Because stand size is small (< 2 ha, 57 individuals in 1977) and genetic variability is therefore limited, individual differences in diameter growth are probably due to microsite differences. Mycorrhizae, which could aid tree survival, were absent from a small sample of surface roots. Although the stand was enlarging in 1977, the site is sufficiently severe that local extinction is a possibility.

Isolated populations of a species are of interest to biologists because such populations frequently represent unique genotypes adapted to particular habitats. In September 1975 and March 1977, we visited a disjunct stand of ponderosa pine (*Pinus ponderosa*) previously reported by Packard (1970). The isolation of the stand, 105 km from the nearest ponderosa pine (Fig. 1), and the reported old age (± 300 years) of a few of its trees (Packard 1970) suggest the possibility of novel ecological relationships or adaptations for extreme drought. In this paper, we describe the status of the stand in 1977, discuss its development, and report changes in diameter growth rates over the past two centuries.

Site and Stand Description

The disjunct stand, located in Malheur County, Oregon, 14.5 km WSW of Rockville (T26S, R45E, Sec. 30, W1/2), occurs on a steep, bare ridge of rhyolitic tuff at approximately 1,450 m elevation. The ponderosa pine are growing along the crest of the ridge

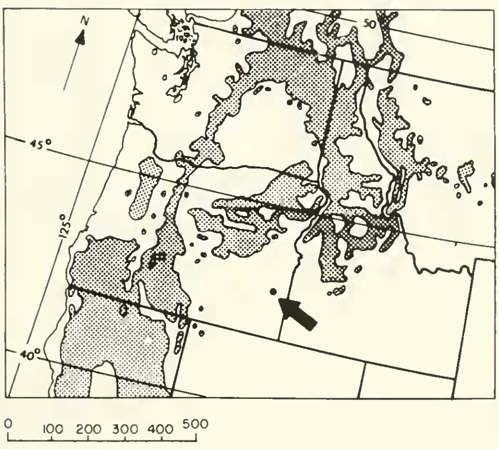

Fig. 1. Distribution of ponderosa pine (shaded area) in the Pacific Northwest. Arrow shows location of the disjunct pine stand (adapted from Little 1971).

Fig. 2. Site overview showing the ridge-top position of the disjunct stand, the rocky mulch nature of the soil surface, and the absence of litter. Tree farthest left is the oldest (as of 1977: 415 years, 14.5 m tall, 75.5 cm dbh).

[1]Paper 1441, Forest Research Laboratory, College of Forestry, Oregon State University, Corvallis, Oregon 97331.
[2]Department of Forest Science, Oregon State University, Corvallis, Oregon 97331.
[3]TREES, Box 14666, Minneapolis, Minnesota 55414, when this work was done. Forestry Sciences Laboratory, Pacific Northwest Forest and Range Experiment Station, Corvallis, Oregon 97331.

TABLE 1. Soil characteristics of the disjunct ponderosa pine stand compared with those of other sites dominated by sagebrush (*Artemisia* spp.) stands in eastern Oregon.

	Disjunct pine stand[a]		Other sites[b]			
			1	2	3	4
County	Malheur		Malheur	Malheur	Baker	Union
Township, range, section	26S,45E,30		17S,43E,12	14S,39E,28	6S,39E,2	8S,41E,18
Soil depth (cm)	0–5	5–15	0–15	0–15	0–15	0–15
Soil pH	6.01	5.65	7.7	7.6	7.6	7.6
Organic matter (%)	0.44	0.42	0.8	1.2	1.2	1.5
Cation exchange capacity (meq/100 g soil)	8.7	7.7	23.8	24.5	34.1	36.7
Extractable cations (meq/100 g soil)						
Calcium	4.9	4.6	15.2	18.0	26.2	29.0
Magnesium	2.1	2.1	5.9	6.4	11.4	12.9
Sodium	0.06	0.06	1.9	1.3	8.2	6.8
Potassium	0.17	0.11	2.2	1.2	1.4	1.6
Kjeldahl nitrogen (%)	0.033	0.027	0.07	0.1	0.05	0.07
Total phosphorus (ppm)	11.0	18.0	10.6	8.5	10.6	5.6

[a]Soil values for the disjunct stand are means of three samples.
[b]Courtesy Oregon State University Soil Characterization Laboratory, Corvallis.

and on the upper portions of the steep northeast and southwest slopes (Fig. 2). The soil surface is covered by a loose, rocky mulch. Soil 0–15 cm deep is slightly acid (mean pH 5.8) with very low carbon content (0.44%) and cation exchange capacity (8.2 meq/100 g soil) (Table 1). Levels of calcium, magnesium, sodium, and potassium are also low, more comparable to levels in humid than semiarid cold, temperate regions (Brady 1974). Although nitrogen levels are low (0.03%), the carbon:nitrogen ratio (15:1) is comparable to that in agricultural soils. Few plants other than ponderosa pine are growing on the site (Fig. 2). Shrub cover is especially sparse compared with that of the surrounding area, which is dominated by big sagebrush (*Artemisia tridentata*) and low sagebrush (*A. arbuscula*) with widely scattered juniper (*Juniperus occidentalis*).

The entire stand covered < 2 ha and contained 57 individuals in 1977. Forty-nine trees were < 25 years old (Table 2). Several seedlings appeared to be < 5 years old, as determined by number of branch whorls and terminal bud scars; five trees were between 26 and 100 years old; and three trees were over 100 years old, the two oldest of which had 415 and 232 annual growth rings at stump height. The largest individual was 75.5 cm in diameter at breast height (dbh) and 14.5 m tall, and only two others were over 40 cm dbh and 9 m tall.

Taxonomic Characteristics

More than 50 needle fascicles from each of 10 trees were examined, and only three-needled fascicles were found. Needles averaged 20 cm long (range: 18–21 cm), which is midrange for ponderosa pine (Mirov 1967); they were dark green and generally appeared to be healthy. Both mature and immature cones were examined from several trees. Mature cones were quite short, averaging 8.1 cm long (range 6–10 cm); immature first-year cones averaged 5.5 cm long. Slightly recurved prickles, rather than the more common straight prickles, were observed, a trait often found on ponderosa pine cones in eastern Oregon.

Discussion

The site clearly is harsh for ponderosa pine, as evidenced by short stature and slow growth of the older trees. Flat-topped crowns show multiple leaders, with none achieving apical dominance (Fig. 2).

Seedling establishment has been infrequent and episodic. Five trees became established near the turn of this century, about 30 trees in the early 1950s, and about 10 trees in the early 1970s. These periods of establishment also were periods of relatively fast diameter growth for the two largest trees (Fig. 3), probably indicating a more favorable cli-

TABLE 2. Number of individuals, by diameter, height, and age classes, in the disjunct ponderosa pine stand.

Diameter (cm)	Height (m)							
	0.5	0.6–1.5	1.6–3.0	3.1–4.5	4.6–6.0	6.1–7.5	7.6–9.0	9.0+
	< 25 years old			26–100 years old			101+ years old	
0–10	32	12	5					
11–20				1	1	1		
21–30							1	
31–40							1	
41–50								2
51–60								
61–70								
71–80								1

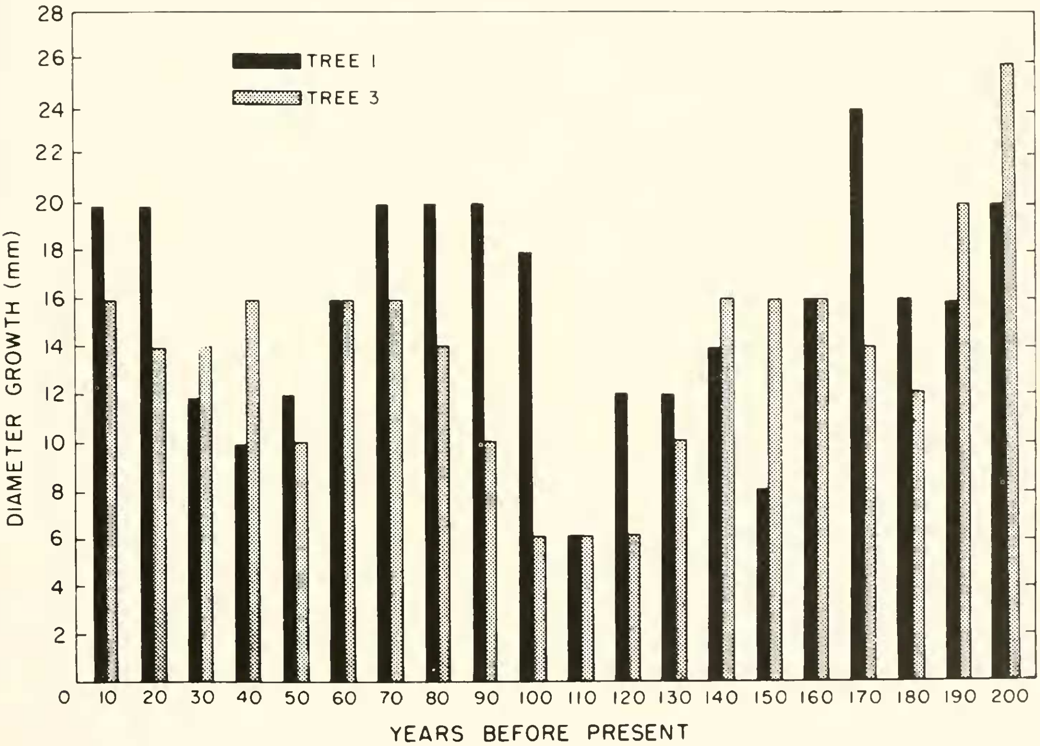

Fig. 3. Patterns of diameter growth, per decade, of the two oldest trees in the disjunct stand (as of 1977: tree #1, 415 years; tree #3, 232 years).

mate. For most of the past 200 years, however, diameter growth has been very slow, with the slowest periods 50 and 110 years ago. The droughty conditions that restrain diameter growth would likely restrict seed germination and establishment of young seedlings as well.

Seedbed conditions also influence establishment. The rocky mulch covering the steep slopes is unstable enough to be moved by frost, wind, and animals; such movement would tend to bury those seedlings managing to get a taproot into the soil. Perhaps more important, the rocky mulch may also reduce interspecific competition by preventing invasion of the site by other plant species. Ponderosa pine has, by far, the largest seeds of any of the local species. A large seed with

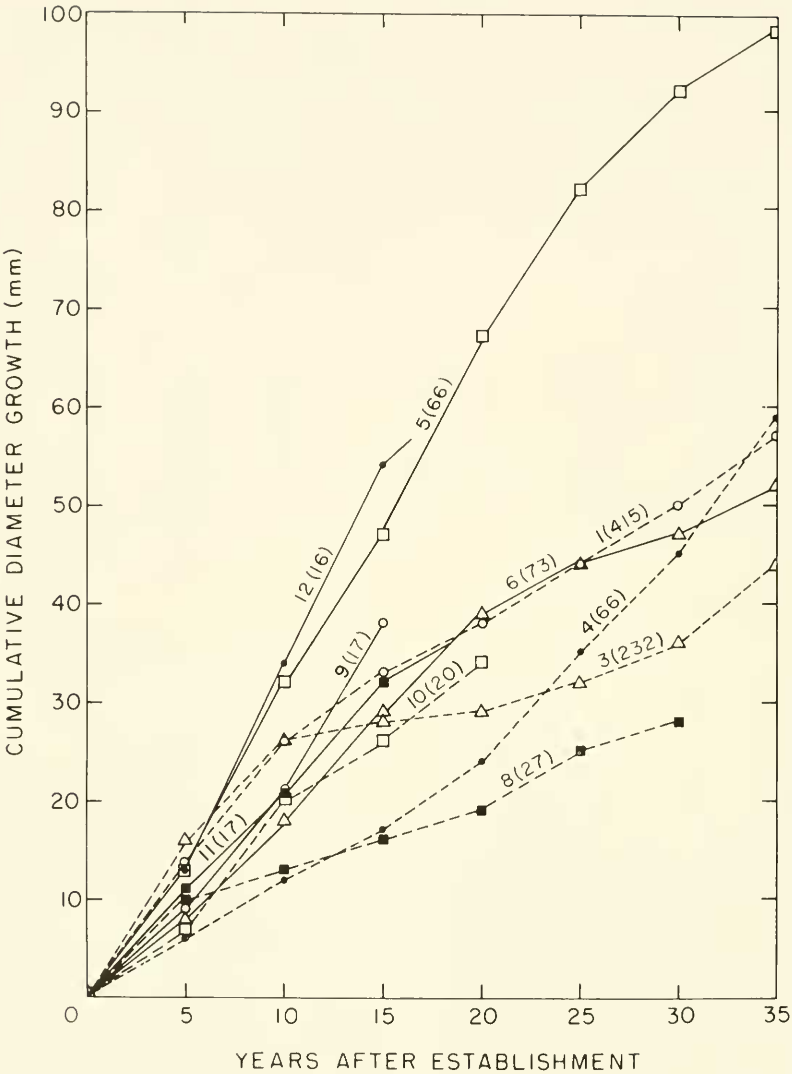

Fig. 4. Cumulative diameter growth of 10 of the largest trees in the disjunct stand (tree number is shown on the line, number of growth rings at stump height in parentheses).

substantial energy reserves may be just what is needed to germinate and rise through the rock mulch. This stand may, in fact, owe its existence to the presence of the rocky mulch despite the difficulties it presents for seedling establishment.

In addition to the harsh climate, insects feeding on seeds seem an important factor regulating establishment. In fall 1975, 15 trees had mature cones, and all were damaged by the pine coneworm (*Dioryctria auranticella*) probably surviving in nearby juniper trees; immature cones were similarly damaged. The same degree of insect damage was observed in spring 1977. If this degree of annual seed predation is typical, then very few sound seeds are available for germination in any given year. This same insect also attacks twigs and shoots (Furniss and Carolin 1977) and might account for the multiple leaders observed in the older trees.

Despite the presence of a fire scar at the base of the oldest tree, fire probably has not been a major factor in stand development because of the lack of on-site fuel (Fig. 2).

We have no explanation for the origin of the stand; perhaps the seeds were carried by Indians or were dispersed by animals. It may be a remnant of ponderosa pine stands existing in the area thousands of years ago when the climate was more favorable. We have no evidence that this is, in fact, a relict stand. There is also no evidence—such as standing dead or downed trees—that the stand has been more extensive in the last century or two. At one time, the population may have consisted of two or perhaps even one individual. Once a tree was established, the general trend was for slow and relatively linear diameter growth during the first three decades (Fig. 4). The data show that variation is as great within a cohort as between. Cumulative diameter growth of trees 4, 5, and 6, all in the same cohort, shows a wide range, which could be due to genetic or microsite differences. Limited cross-pollination in this very small population would have greatly reduced genetic variability; therefore, variations in growth are probably the result of variations in microsite conditions.

Particular mycorrhizal fungi can enhance the survival of their coniferous symbionts. *Cenococcum geophilum* and *Pisolithus tinctorius* both form mycorrhizal associations on droughty sites (Trappe 1977). However, no mycorrhizae were found in small roots near the soil surface nor were any mushrooms present in the area. Because ponderosa pine has a deep taproot, extensive excavation would be necessary to thoroughly evaluate the presence and identity of mycorrhizal fungi.

The survival of this stand is uncertain. The large number of seedlings relative to the number of mature trees indicates a new period of stand enlargement. The site is sufficiently harsh, however, and the population so small as to make local extinction a serious possibility.

Acknowledgments

We thank Carol Perry and the editorial staff at the Forest Research Laboratory, Oregon State University, Corvallis, for their help in preparing the manuscript.

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